Passenger Route Choice and Assignment Model for Combined Fixed and Flexible Public Transport Systems

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SCRIPTS

(Smart Cities' Responsive Intelligent Public Transport Systems)

Trends in public transport systems

Traditional public transport

Emergence of Demand Responsive Services

Combined system improves overall efficiency

Need for new models to understand how users combine line/schedule based public transport services and demand responsive services?

1. **Introduction**
2. Literature gap and research question
3. Methodology
4. Integrated public transport route choice model
5. Application
6. Results
7. Conclusion

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Literature gap and research question

- Existing literature
  - Route choice modelling largely ignored
  - On-demand services modelled in isolation
- **Major research question:** Modelling the integrated route choice of users combining fixed and flexible public transport systems

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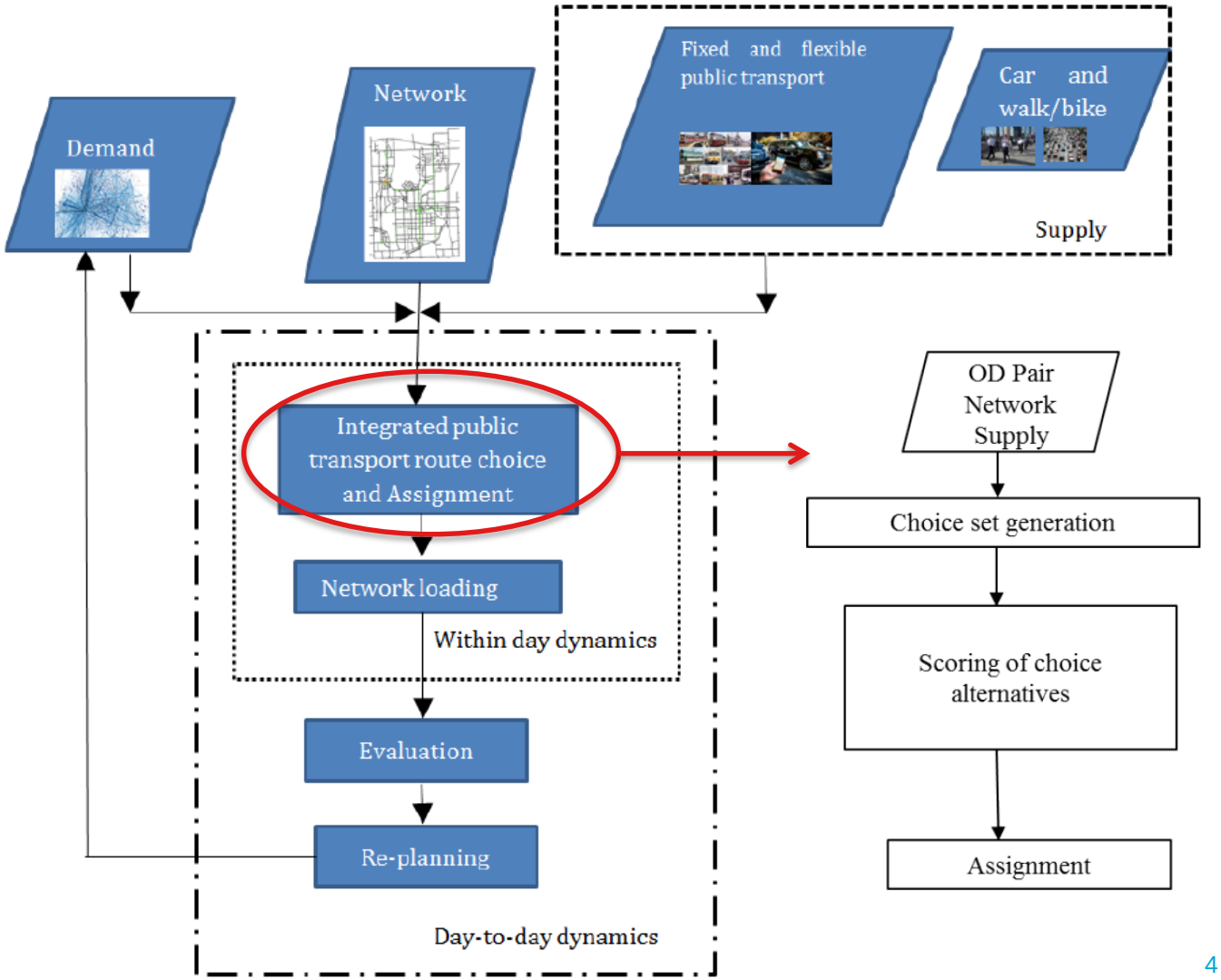
Overview of the methodology

- **Agent based simulation method**



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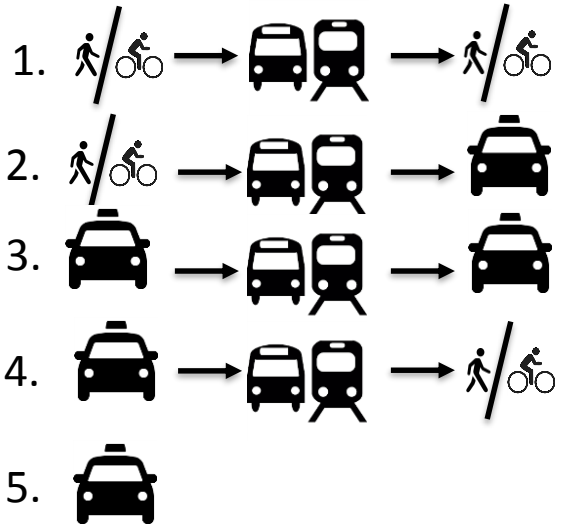
Integrated public transport route



Line/Schedule based services

Fixed PT

Flexible PT

- Real time booking
- Door-to-door services
- Fleet of vehicles controlled by a central dispatching unit

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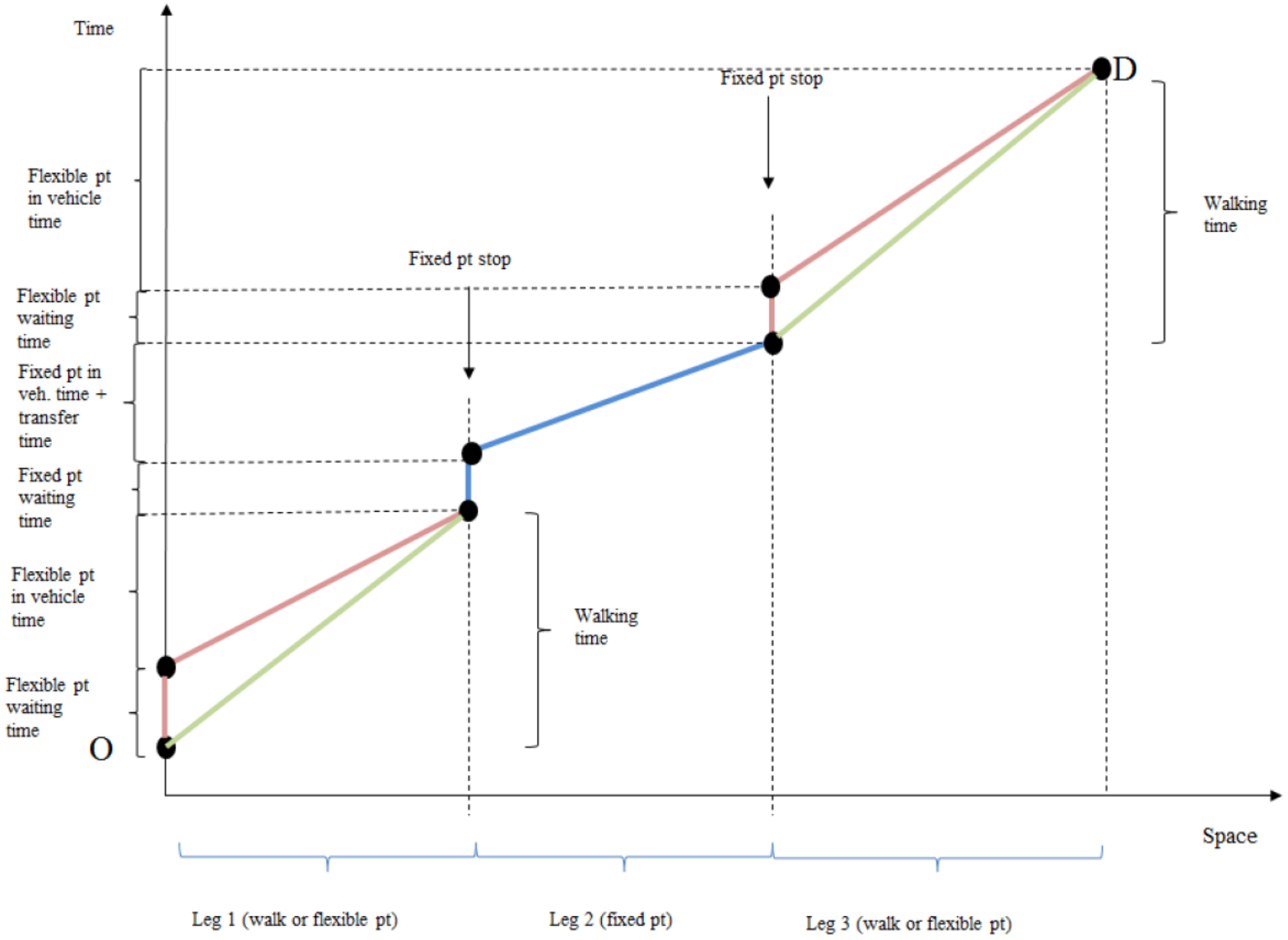
Integrated public transport route (1,2,3, and 4)



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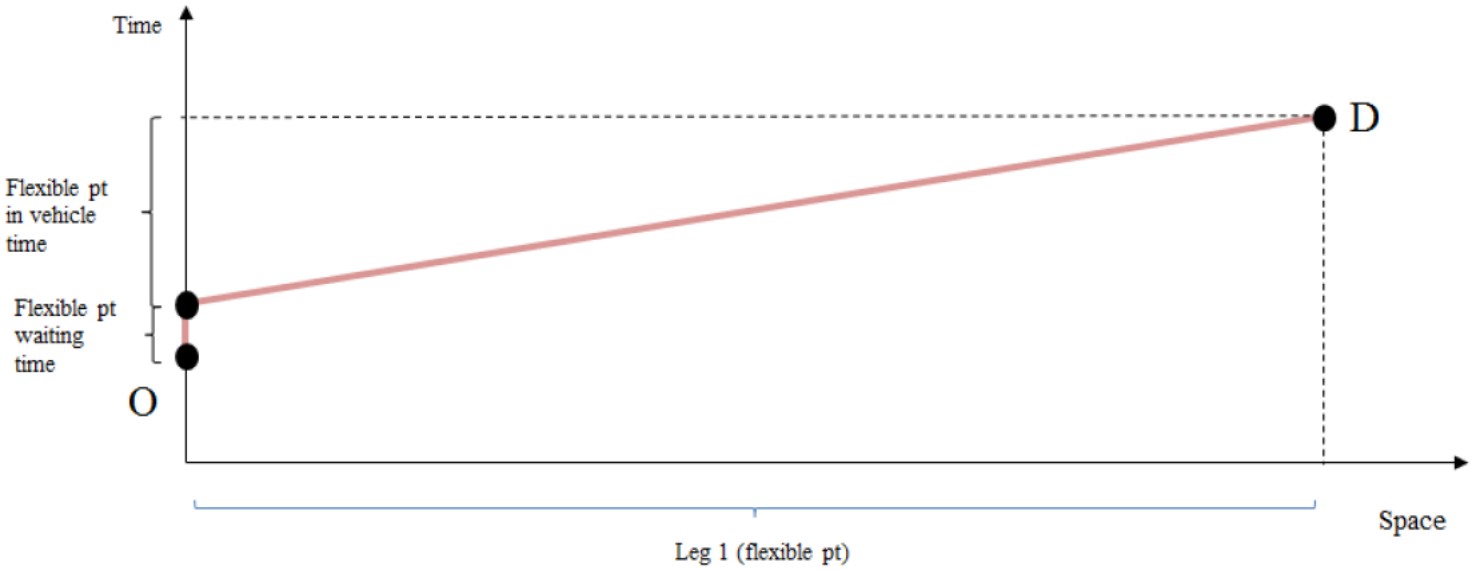
Integrated public transport route (5)



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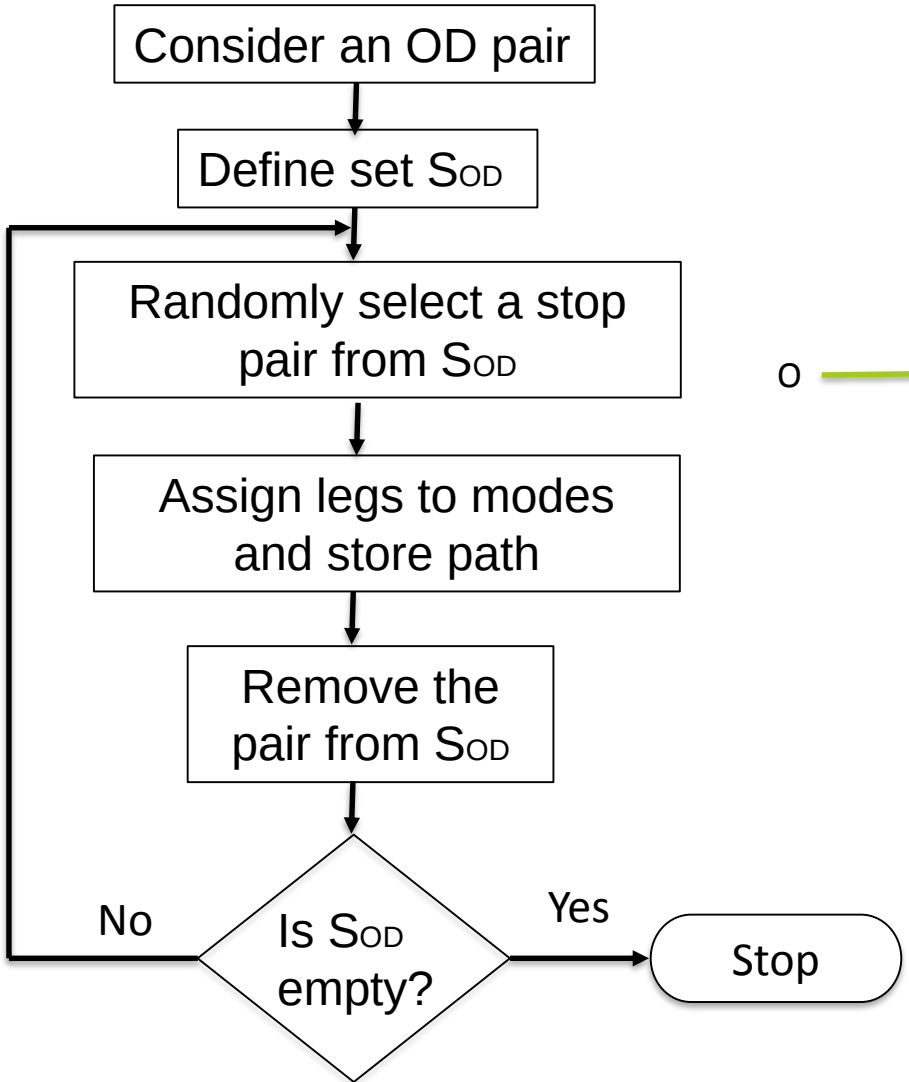
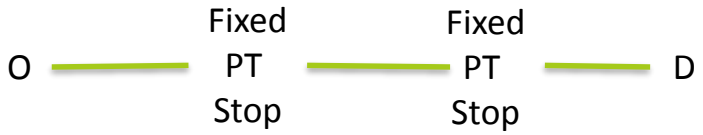
Integrated public transport route choice model

- **Choice set generation**





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Integrated public transport route choice model

- **Scoring of choice alternatives**

$$U_i = \beta_{walk/bike}.t_{walk/bike} + \beta_{transfer}.N_{transfer} + \sum_{m=fixedpt,flexiblept} [\beta^m_{wait}.t^m_{wait} + \beta^m_{inveh.}.t^m_{inveh.} + \beta_{money}.p^m.d^m]$$

- **Assignment**

$$P(U_i) = \frac{(PS)_i.e^{U_i}}{\sum_{j=1}^{N} (PS)_j.e^{U_j}}$$

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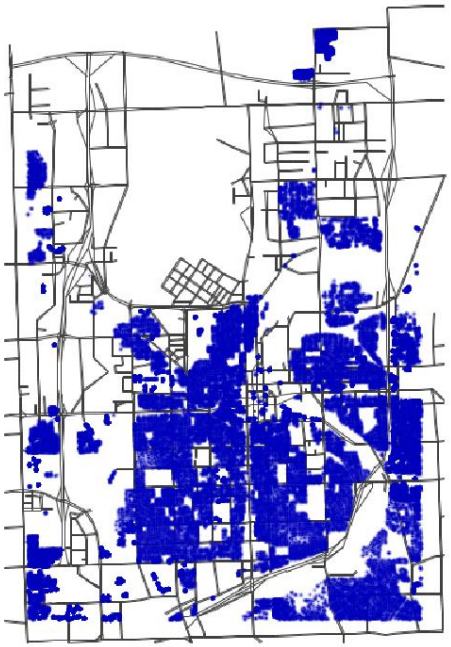
Case study

Simulation setup

Test network: Based on the city of **Sioux Falls** in the United States

Modes available: Car, Walk, Fixed PT, Flexible PT

Implementation platform: MATSim



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Simulation Scenarios

Scenario	User Choice				
	Car	Walk	Fixed PT only	Flexible + flexible PT	Flexible PT only
Base scenario	Y	Y	Y	N	N
Fixed or flexible PT	Y	Y	Y	N	Y
Fixed + flexible PT	Y	Y	Y	Y	Y

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Market share

Scenario	User Choice				
	Car (%)	Walk (%)	Fixed PT only (%)	Flexible + flexible PT (%)	Flexible PT only (%)
Base scenario	66	<=1	33	NA	NA
Fixed or flexible PT	62	<=1	23	NA	15
Fixed + flexible PT	61	1	9	15	14

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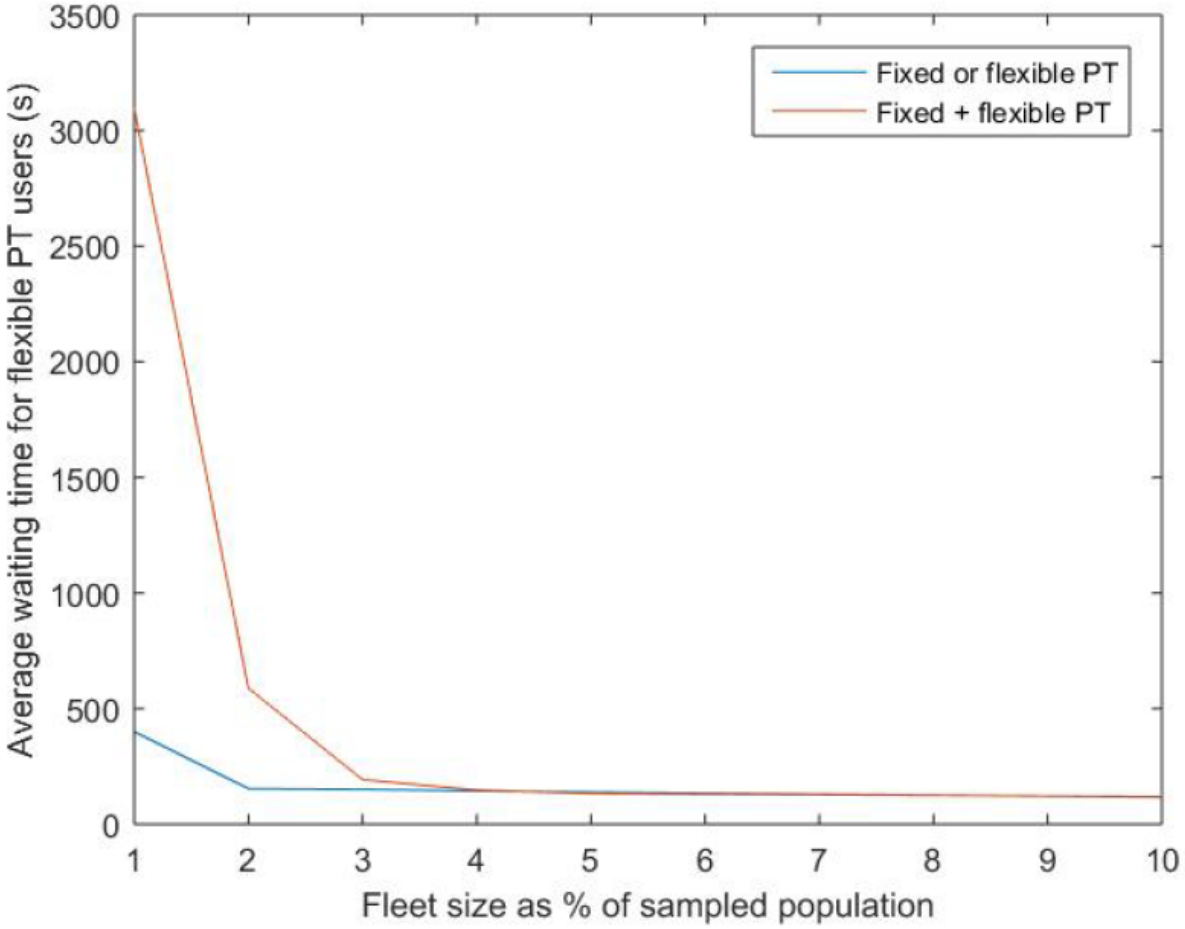
Average waiting time vs fleet size



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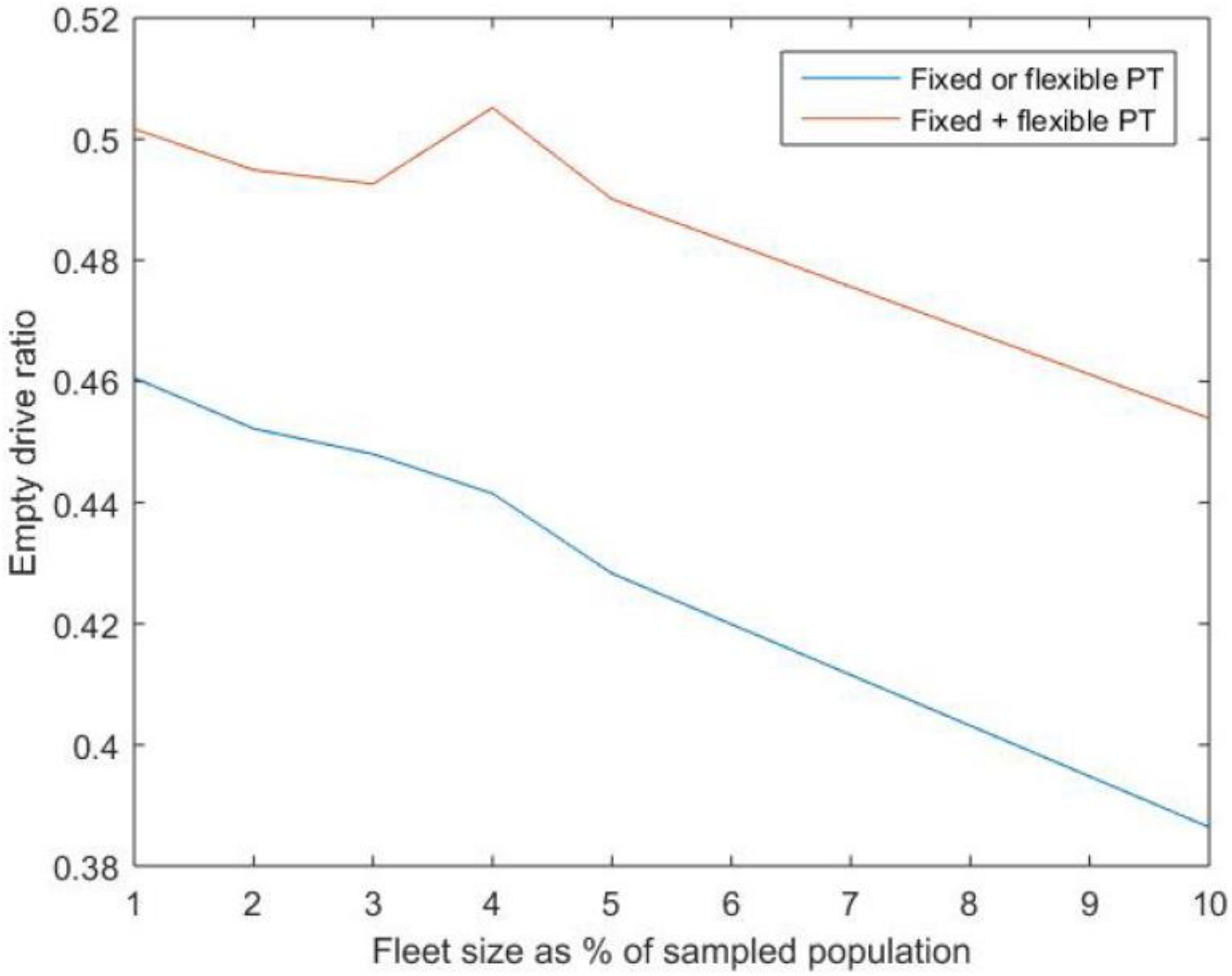
Empty drive ratio vs fleet size



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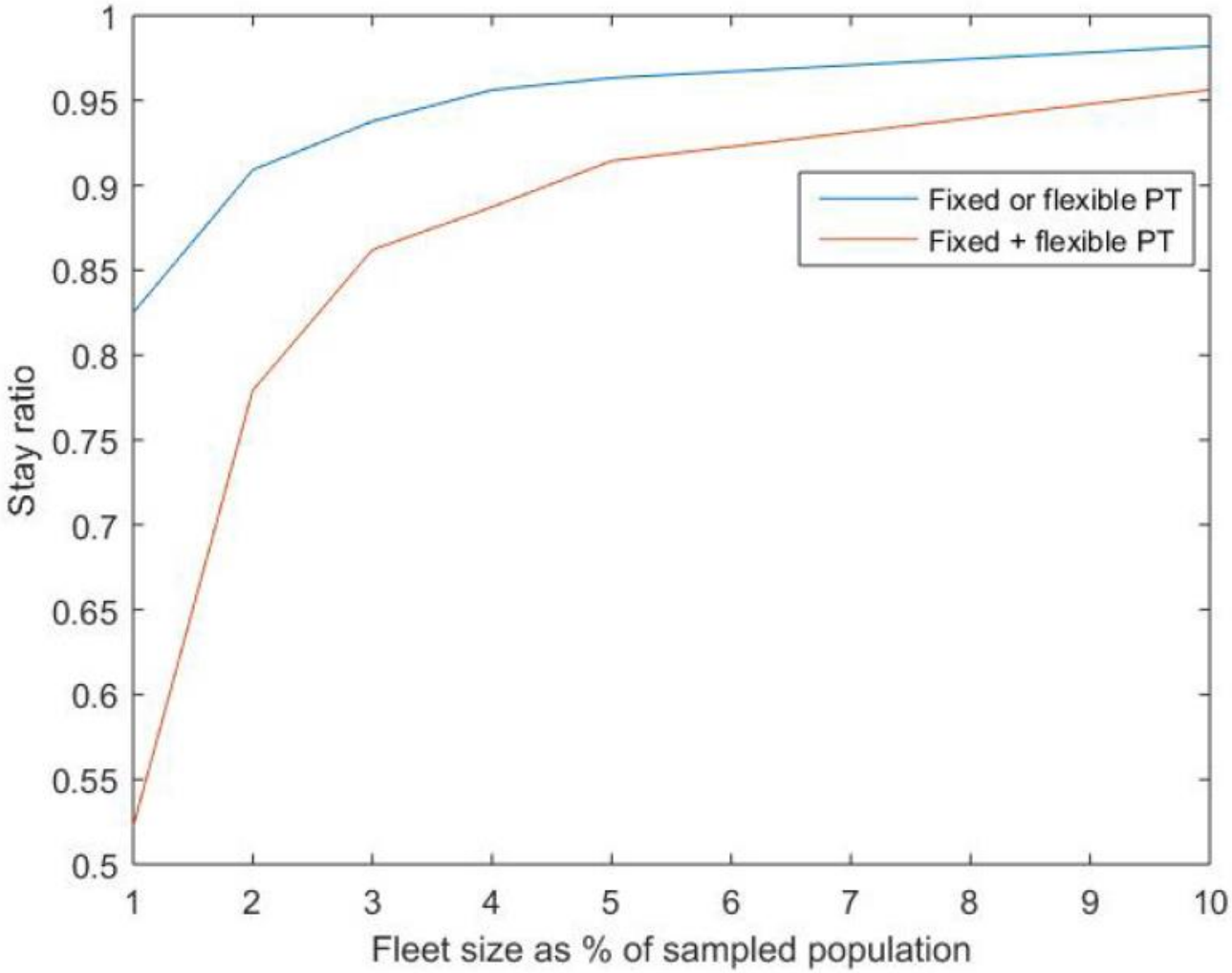
Stay ratio vs fleet size



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Key findings

- This study developed a multimodal route choice and assignment model for combined Fixed and Flexible PT services
- The analysis showed that the mode share of Fixed PT + Flexible PT comes from the mode shift from Fixed PT
- The effect on waiting times of passengers by increasing fleet size is not pronounced beyond a certain point
- Fleet size of Flexible PT remains largely underutilized at higher fleet

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Practical relevance and future direction

- **Practical relevance:** The model enables practitioners and policy makers to understand how users choose Fixed and Flexible PT services when operating under competition and cooperation
- **Future direction:**

  Implement model for network of Amsterdam (**Simulation visualisation**)

  Developing a modelling framework to optimise Fixed and Flexible services

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Thank you!

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